Hunting the Quark Gluon Plasma
Can laboratory experiments re-create the origins of matter?

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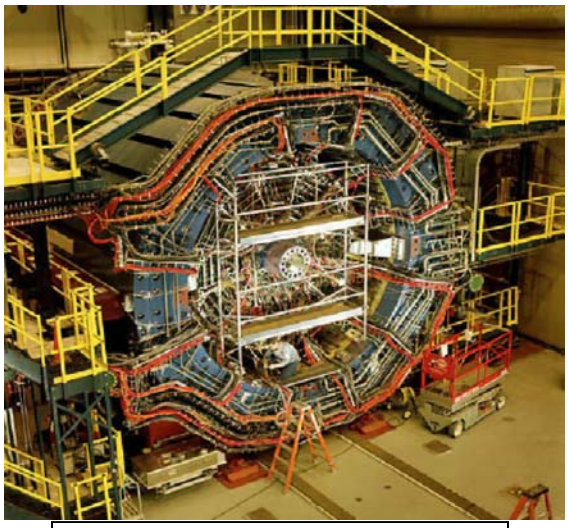
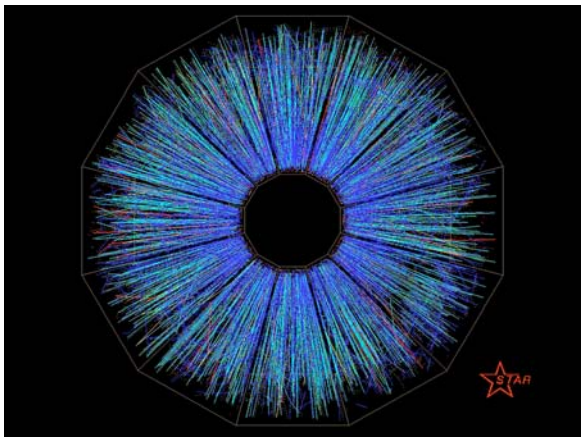
The quest to understand the nature and origins of matter at its most basic level is as old as civilization. Some 30 years ago experiments with high-energy collisions of subatomic particles demonstrated that the basic building blocks of atomic nuclei, the protons and neutrons, are not "elementary" particles, but structures made up of quarks, inextricably bound together by forces carried by particles called gluons. Theory now predicts that at extraordinarily high temperatures and densities – conditions that have not prevailed in the natural universe since a few microseconds after the Big Bang – matter takes a different form, consisting not of neutrons and protons, but an extended volume of interacting quarks, anti-quarks, and gluons. This is the Quark Gluon Plasma, the state now thought to have been the precursor for all of the observable matter in the present universe. It is believed that the conditions to create this extreme form of matter can be reproduced in very high energy collisions of heavy nuclei.

The creation and study this new state of matter in the laboratory is the goal of the newly constructed Relativistic Heavy Ion Collider, RHIC, which is now producing collisions of heavy nuclei at the highest energies ever achieved. The early experiments at RHIC have shown in dramatic fashion that the predicted conditions for realizing the transition from ordinary matter to "quark matter" can indeed be reached, and provide evidence that a new form of matter is being observed. This lecture will discuss the basic phenomena that drive this field of research, describe the data and the nature of the experiments that are being carried out, and discuss the scientific implications of the results so far.



The STAR detector at RHIC



The aftermath of a collision of two gold nuclei, with an energy about 100 times the rest mass of the colliding ions, seen in the STAR detector.